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The geological information collection system design based on wireless sensor network

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Abstract

On the basis of analysis of characteristics of ZigBee wireless sensor networks, this paper uses the modular method to realize the ZigBee agreement stack. From the system's hardware and software processes, etc., describes remote acquisition of geological information and wireless monitoring system design based on wireless sensor networks, the system reliably implement features such as temperature and humidity monitoring, ad-hoc networks with low power, low cost, high reliability features.

Keywords: ZigBee technology; geological information; wireless monitoring;

China's collapse, landslide and debris flow geological disasters occur very frequently, thus resulting in extensive loss of life and enormous economic losses each year. Collapse, landslide, debris flow is also a serious threat to the farmland, villages, irrigation facilities and major transportation routes safe, therefore, the unattended geological information automatic, real-time, remote collection, monitoring is necessary.

Wireless sensor network (WSN) is an integrated information system, including information collection, information transmission and information processing function, It is a "smart" measurement and control network, Deployed within the monitoring area, by a large number of cheap, with communication, sensing and computing capacity of micro-sensor nodes, though self-organization. In order to effectively monitor the sensitive areas of the geological environment, enhance the fight against geological disasters, and promote the automatic warning and forecast of geological disasters. Presented are based on geological information gathering in wireless sensor network monitoring project, to bring about the occurrence and spread of geological disasters forecasting and prediction, provide geological disaster prevention and emergency command with the correct decision support.

1. ZigBee's technical characteristics

ZigBee technology is a kind of uniform technical standards for short-range wireless communication technology. Complete ZigBee protocol stack is formed by the physical layer, media access control layer, network layer, security layer and application layer. The physical layer and media access control layer protocol is the protocol standard IEEE802.15.4.The network layer and security layer were developed by the ZigBee Alliance, the development of application layer can be adjusted according to the user's own need. The system of ZigBee module of block diagram shown in Fig 1.

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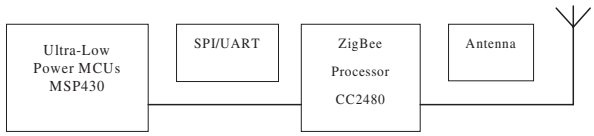

Fig.1 ZigBee module block diagram of the system

2. Overall design of geological information collection system

Geological information collection monitoring system main function is to monitor temperature and humidity data collected in the region, and summarize the data to a remote data center. Main function: ①Realization of data acquisition; ②The achievement of the node data to the coordinator. ③The achievement of centralized and remote transmission of data on the coordinator. This article has designed a programme which is collocation of GPRS wireless wide area network using ZigBee network, Conduct research on star network topology. Network consists of several ZigBee terminal node and a ZigBee ZigBee Coordinator built into a star-shaped WSN, by sensor on the terminal node to collect environmental parameters (temperature, humidity, light and movement, and so on), Environmental parameters then transmitted to the coordinator through terminal wirelessly respectively. The coordinator receiveeddata for fusion processing, then from the gateway node through the Internet via GPRS module reached the remote control center. The programme's low cost, easy to implement, It can collect, process and analysis inginformation at any time for any location. As shown in Fig 2.

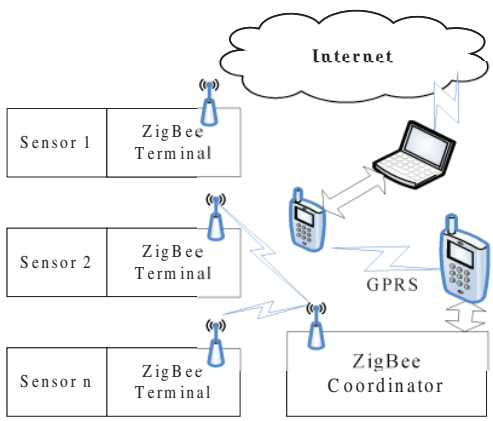

Fig.2 Structure of wireless network

WSN nodes including the ZigBee terminals and the coordinator, Using MCU plus RF chip mode to meet the complex geological environment monitoring applicability and stability requirements. Each node consists of data acquisition sensors, processing module, wireless communication module and power module.

2.1. Data transfer process

Monitor host issued commands to query the various indicators of the monitored area, the commands transmitted via satellite or Internet to the ZigBee coordinator, ZigBee coordinator and then select the command to query based on the terminal nodes; ZigBee network will automatically search path, after the router receives a control command, it will activate all of its connected nodes to communicate. Terminal node by connecting the sensor to collect data immediately, after DAC the data send to router, then from the router to the ZigBee coordinator, and through the Internet to a remote control center after GPRS transmission. All the network's MAC layer of ZigBee devices have a 64-bit IEEE address, l6-bit short addresses can be used to reduce the packet size. When the node is placed, the number of nodes should corresponds to the geographical location of the place, and enter the database of the control center. So after recording terminal address, by node number can easily determine the geographical location of the sensor. After the control center receiving the data, through the analysis of data, based on information such as temperature, light intensity, humidity, displacement, the control

center can accurately find the location of the sensors which send alarm information, and then processed in a timely manner.

2.2 Data acquisition unit

Temperature, soil humidity and light are important physical parameters of the monitored area. In this paper, temperature data collection as an example to introduce the wireless sensor data acquisition unit. Digital temperature sensor using DS18S20 chip; The sensor is 9 digits of precision, and I2C interface, temperature range is-55~125℃, 12-bit digital form, sensitivity to 0.0625 ° c. Through Single-wire Serial Interface to send and receive information, including three ground (GND) pins, data input / output pins (DQ) and power (VDD).

2.3 Microprocessor unit and wireless communication unit

Processor unit is the core of WSN nodes, together with other units to complete data acquisition, processing and sending. ZigBee protocol stack requirements to the system microprocessor includes: 8-bit microprocessor; Full function device (FFD) node protocol stack, ROM <32k; simple function device (RFD) node protocol stack, ROM about 6k; Coordinator also need enough RAM, for storing the node bindings, routing tables and other information. Select TSZ003 ZigBee development platform in this article, communication processing module using the CC2480 module.

2.4 Multi-channel data acquisition module

Supply voltage: 9~12V DC power supply; AD channel: ≥ 6; signal input range:-5V~+5V; signal input interface: ≥ 4 core aviation plug interface, ≥ 2 standard BNC connector; Input impedance: ≥ 10M ω; Extensible DA channel: ≥ 2; DI digital input channels: ≥ 2, Optical isolation, 5V/12V/24V;DO digital output channels: ≥ 2, direct-drive relay; sampling frequency: 100KHz/250KHz/500KHz; sampling accuracy: ≥ 12-bit resolution; A/D start mode: programmable trigger.

3. Software design of wireless sensor network module

3.1. Software architecture

The software on the ZigBee wireless sensor network devices is mainly composed of embedded operating system software, ZigBee protocol stack and application program, embedded operating system kernel provides a simple and efficient task transfers, interrupt handling and time queue management, also includes all the underlying hardware driver. Applications program include serial communications, RF communications, and signal strength detection. It uses modular design protocol stack, makes the whole System-level clear, good scalability, conducive to the secondary development of ZigBee technology.

3.2 .Stack Design

ZigBee protocol stack to ensure that wireless devices in the low-cost, low power and low speed network interoperability. ZigBee protocol stack of different layers communicate through the service access point, Most layer has two interfaces: data entity interface and management entity interface. Data entity interface goal is to provide top service routine data. Management entity interface goal is to provide the mechanisms including access to the upper inside layer parameters, configuration and data management. Its basic structure as shown in Table 1.

Table 1.The structure of the ZigBee stack

The Structure of The ZigBee StackApplications	ZigBee Device object
Application layer (APL.h/APL.c)	Application Support Sublayer(APS.h/APS.c)
Network layer (NWK.h/NWK.c)	
Link layer media (MAC.h/MAC.c)	
Physical layer (PHY.h/PHY.c)	

ZigBee technology has defined the standard specification of the physical layer, link layer and network layer, therefore, the realization of these three layers are usually similar. Wireless sensor network's different applications are composed from the basic application, such as join the network, break away the network, send data, etc. This article uses the IAR Embedded Workbench for 8051 software to program the physical layer, media-link layer and network layer code of the system platform, each of the header file defines each layer of the support of the services and application program interface. Meanwhile, the platform also provides a number of application interface, for example aplFormNetwork (), plJoinNetwork (), aplSendMSG (), etc. Users can call these functions to achieve their development and application.

3.3 Introduction to system application layer

The system combines data acquisition and serial communication functions. GPRS sends command information, the coordinator receives commands through the serial port, and then sent to the next terminal node or router. If the router receives the command information, it will automatically choose the best path to find the terminal node. Then sensor nodes send the data to the coordinator by methods of multihop relay, Finally, the coordinator send all the data of the network to the remote control center for centralized processing through the Internet via GPRS module.

3.4 The main program

After building a network using the coordinator, terminal nodes and routers join the network composed of a star topology. Using SimpleApp program as a template to build the project, Using it for wireless data transfer, then add SerialApp program and add new tasks for the serial communication. In zb_HandleOsaEvent, in addition to adding networking and updating network state, also need to add event-handler function to sensing information, for terminal nodes, the main task is to process the sensing data, and transmit to the coordinator. For the coordinator, it need to add the receive terminal node of the data and GPRS command event handler function. The trigger process of event handler function as shown in Figure 3.

4. The ZigBee network has the following features:

- Low power consumption. In the low-power standby mode, two AA size batteries can support one node to work 6 to 24 months, if use lithium batteries, such as L71 and other industrial batteries, the capacity can be achieved 3AH, its use of time up to 10 years.
- Low-cost. By dramatically simplifying protocol, reducing the requirements for communication controller, 8051 8-bit micro-controller to measure, sub-function nodes as small as 4KB code, and the ZigBee protocol is a royalty-free.
- Low rates. ZigBee communication work in the rate of 250kbps, can meet the application requirements of low-rate data transmission.
- Short distance. Transmission range is generally between (open range) 10 ~ 100m, after the increase in RF transmit power can also be increased to (open range) 100m～1km. This refers to the distance between adjacent nodes. If the communication between nodes and routing by relay, the transmission distance can be further. It can fully meet the requirements of teaching system.
- Short delay. The ZigBee is fast response, In general, from sleep into the work state needs just 15ms, and nodes connect into the network needs only 30ms, further save energy.
- High capacity. This ZigBee network using star network topology, Manage 254 sub nodes through the master node; at the same time, the master node can be managed by upper layer network node, composed of up to 65,000 node network.
- High security. ZigBee provides a three-tier security model, Including non-security settings, use the access control list (ACL) to prevent illegal access to data and the use of Advanced Encryption Standard (AES128) for symmetric encryption, to ensure its security attributes with flexibility.

- License-free frequency bands. Direct sequence spread spectrum in the industrial scientific medical 2.4GHz (global) (ISM) license-free frequency bands.

5. Conclusion

ZigBee network system has the following features such as low-cost, easy to implement, reliable data transfer, low power consumption, with security at all levels, it is practical, suitable for outdoor environments. This article designed a ZigBee star networks use a small number of continuously supply nodes as the main body, It is a realization of a low implementation cost, low maintenance, high degree of automation, remote monitoring system of geological information collection. With the development of modern science and technology, we can foresee the ZigBee wireless sensor network as a new technology will be widely used.

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